I Claim:

1. A method for multi-input multi-output channel estimation, the method comprising:

transmitting training sequence signals from a plurality of transmitting antennas, through said MIMO channel, such that training sequence signal transmissions from at least two of said plurality of transmitting antennas overlap in time;

receiving said training sequence signals at a plurality of receiving antennas, through said MIMO channel; and

comparing said transmitted training sequence signals with said received training sequence signals to generate an estimate of a characteristic of said MIMO channel.

2. The method of claim 1, wherein said estimate of a MIMO channel characteristic comprises a set of coefficients wherein, for each receiving antenna, at least one coefficient corresponds to each transmitting antenna.

3. The method of claim 1, wherein said transmissions from at least two of the plurality of transmitting antennas occur substantially simultaneously in time.

4. The method of claim 1, wherein said training sequence signals have equal power spectral density in frequency and time.

5. The method of claim 4, wherein said training sequence signals are chirp signals.

6. The method of claim 4, wherein said training sequence signals are sent in blocks and each block is preceded by cyclic prefixes.

7. The method of claim 5, wherein said blocks number as many or more than said transmitting antennas and during one block all transmitted training sequence signals share a same phase.

8. The method of claim 7, wherein during other blocks, all transmitted training sequence signals have a different phase.

9. The method of claim 8, wherein said estimate is generated, at least in part, by a transform based procedure.

10. The method of claim 8, wherein said blocks number N_{block} and said transmitting antennas number N_{TX} where N_{block} is greater than or equal to N_{TX}, and said blocks are numbered according to t where t -> 0..., N_{block}-1, and said transmitting antennas are numbered according to m where m -> 1... N_{TX}, and said transmitted training sequences, $x_m[t,k]$ are proportional to:

$$x_m[t,k]=\exp(2\pi jmt/N_{block})\exp(\pi jk^2/T_{chirp})$$

where integer T_{chirp} is the period of the sequence, which equals the length of the training block without the cyclic prefix.

11. The method of claim 1, wherein said training sequence signals comprise a plurality of subsequence signals.

12. The method of claim 11, wherein said subsequence signals comprise an optimal or near-optimal training sequence due to their preserved orthogonality at the receiver.

13. The method of claim 11, wherein said method further comprises:
estimating said channel characteristic for each subsequence;
estimating phase differences between each received subsequence;
combining estimates to estimate the channel response.

14. The method of claim 13, wherein said estimating said channel characteristic for each subsequence comprises estimating said channel characteristics for each subsequence using a transform-based channel characteristic estimation procedure.

15. The method of claim 13, wherein said estimating phase differences between each received subsequence comprises estimating phase differences between each

received subsequence using a partial, subsequence-based phase difference estimation procedure.

16. The method of claim 15, wherein said combining estimates to estimate the channel response comprises combining estimates to estimate the channel response using a phase-correcting estimation combining procedure.

17. The method of claim 15, when subsequences are composed of Ntx blocks each and given by Eq. (22) as follows:

$$x_m[t,k] = \exp(2\pi jmt / N_{block})x_{chirp}[k].$$

18. The method of claim 15, wherein each subsequence is one block long, and a block comprises a cyclically-prefixed chirp sequence.

19. The method of claim 15, wherein said subsequences are shorter than Tblock and given by Eq. (20) as follows:

$$x_{p,q}[k] \propto \exp\left[\pi j \frac{pk^2 + 2qk}{L_{block}}\right]$$

20. The method of claim 15, wherein the method further comprises denoising the channel estimate by:

calculating a time-domain channel response having a first set of coefficients based, at least in part, on a transform-based procedure performed on the channel estimate;

truncating the time-domain channel response by selecting some of the first set of coefficients and not selecting others of the first set of coefficients;

calculating a denoised channel response by performing a transform-based procedure on the truncated channel response.

21. An apparatus for generating an estimate of a MIMO channel comprising

a plurality of transmit antennas configured to transmit a plurality of training sequences through said MIMO channel;

a plurality of receive antennas configured to receive said plurality of training sequences through said MIMO channel; and

a receiver coupled to said second plurality of antennas configured to generate an estimate of a response of said MIMO channel comprising a coefficient for each transmit antenna-receive antenna pair.

22. The apparatus of claim 21, wherein said receiver is further configured to denoise said estimate.

23. A method for denoising an estimate of a wireless channel having a short impulse response, the method comprising:

estimating a frequency domain channel response;

calculating a nontruncated time domain channel response by performing a first transform-based procedure on said frequency domain channel response and wherein said nontruncated time domain response comprises a first set of coefficients;

truncating said nontruncated time-domain channel response by selecting certain of the first set of coefficients and not selecting others of said first set of coefficients to generate a second set of coefficients that define a truncated time-domain channel response; and

calculating a denoised frequency-domain channel response by performing a second transform-based procedure on said truncated time-domain channel response.

24. The method of claim 23, wherein said first transform-based procedure is an inverse Fourier transform and said second transform-based procedure is a Fourier transform.

25. The method of claim 23, wherein said first transform-based procedure is an inverse Fast Fourier transform and said second transform-based procedure is a Fast Fourier transform.

26. A set of orthogonal signals that, when transmitted and received through a multi-input multi-output channel, remain orthogonal.

27. A method to estimate Multiple-Input Multiple-Output (MIMO) wireless channel with simultaneous or overlapping transmission by different transmitter, and to reduce peak power requirements and/or training time and/or estimation error.

28. An apparatus to estimate Multiple-Input Multiple-Output (MIMO) wireless channel with simultaneous or overlapping transmission by different transmitter, and to reduce peak power requirements and/or training time and/or estimation error.

29. A method to reduce mean-squared estimation error by denoising estimate of a wireless channel with short impulse response.

30. A method to reduce mean-squared estimation error due to phase noise and frequency offset between transmitter and receiver local oscillators and local oscillators. The method is based on training sequences built of successive subsequences, such that their processing at the receiver yields estimate slow changes in the phase offset between transmitter and receiver.

31. A receiver comprising:

I/Q (in-phase/quadrature) modulators, intermediate-frequency (IF) amplifiers, mixers, power amplifiers, bandpass filters, multiple receiving antennas, and a local oscillator.

32. A transmitter comprising:

I/Q (in-phase/quadrature) demodulators, intermediate-frequency (IF) amplifiers, mixers, low-noise amplifiers (LNA), bandpass filters, multiple receiving antennas, and a local oscillator.

33. A transmitter signal control system for generating a plurality of simultaneous training sequences, comprising:

a generator of chirp sequences,

a cyclic prefix adder, and

a phase rotator.

34. A communication system comprising:

a plurality of transmitters;

a plurality of receivers;

a plurality of transmit and receive antennas; and

digital signal processing hardware and/or software for channel estimate, which disentagles the signals arriving from different transmitters by transform-based techniques in both frequency and spatial domains, and compensates for frequency offset and phase noise in the local oscillators at the transmitters and receivers by using the redundancy in the received training signals.